Pacific Institute *for the* Mathematical Sciences

Year in Review 2016 & 2017

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Ruth A. Situma, Program Manager

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Melania Alvarez, BC Education Coordinator

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Sean Graves, University of Alberta

Indy Lagu, University of Calgary

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Dr. Vaho Rebassoo, Former Chief Information Technology Officer (IT Services), Boeing

Dr. Nicole Tomczak-Jaegermann, Department of Mathematical and Statistical Sciences, U Alberta

Dr. Sandra Zilles, Associate Professor of Computer Science; Canada Research Chair (Tier 2) Computational Learning Theory, U Regina

Cover Image: Winnipeg, Manitoba by JimJH, courtesy of istock.

From the Director

ln 2016, I was delighted to be named the new Director of PIMS. Taking over for the Acting Director, Martin Barlow who had stepped in to fill the substantial void left by Alejandro Adem when he left in early 2015 to become MITACS CEO, was both a daunting honour and a fantastic challenge. Martin steered the ship until July 1st, when he passed the baton onto me.

My goal as director is to meaningfully enhance the research, teaching and collaboration capacity of all the mathematical scientists that PIMS serve. There is a great deal of incredible work being done to further our mandate of promoting dialogue and awareness surrounding the mathematical sciences that often flies under the radar, and I want to not only give voice to these successes, but further support and expand them.

In 2016 PIMS launched two new CRGs: Geometric and Cohomological Methods in Algebra, and Geometric Analysis. (Please read more about these on pages 4 and 5.) I believe in collaborative endeavour in all sciences and our CRGs serve to help advance both research collaboration and mathematical science as a whole.

2016 also marked the second year of our Postdoctoral Training Centre in Stochastics with a new cohort of postdocs representing Politecnico di Milano, U. Cambridge, UCalgary, UAlberta, UBC and UWashington. The retreat at BIRS ran September 23-25 (Read more on page 9.), nearly doubling in size from the previous year.

Through 2016-2017, under the leadership of Michael Lamoureux, the PIMS innovation programs have made amazing strides in enhancing the PIMS relationship with industry and education through platform launches and collaborative workshops. (See pages 14, 15 and 16.) In particular, the launch of our Jupyter platform for open source course content and the Graduate Mathematical Modelling in Industry Workshop (GMMIW), a joint project with Le Centre de Recherches Mathématiques, the Fields Institute, and PIMS, were outstanding successes. As the problems of today and the future are increasingly solved by the mathematical and digital toolchest, attending workshops like the GMMIW are an important step for our graduate students and postdocs on their way to impactful careers.

The PIMS Education program, due to the outstanding leadership, passion and initiative of our education coordinators, continues to change the lives of students and teachers from all walks of life. Melania Alvarez (UBC); Malgorzata Dubiel (SFU); Sean Graves (UAlberta); Darja Kalajdzievska (UManitoba); Indy Lagu (UCalgary); Jane Butterfield (UVic) and Patrick Maidorn (URegina) are to be commended for the work. Math literacy is not just important for students but for teachers as well, and the efforts of our education coordinators are making substantial inroads in improving how math is presented to students.

Funding for our work comes from a broad spectrum of interests and donors. We are grateful for all the support we receive and would like to thank everyone who makes our educational outreach and innovation initiatives possible: Actuarial Foundation of Canada, ARC Resources Ltd., Brian Russell, Vice-President, Software Hampson-Russell, Calgary Calfrac Well Services Ltd., Haig Farris, President, Fractal Capital Corporation, Kinder Morgan, Neysa Finnie, President, St. Thomas More Collegiate, SpencerCreo Foundation, Vaho Rebasso, (former) Chief Technology Officer, Boeing Information Technology, The Boeing Company, Vancity, Vanguard Charitable Endowment, and the Willow Grove Foundation.

James Colliander
Director

About PIMS

The Pacific Institute for the Mathematical Sciences was founded in 1996; it is a consortium of universities in the Pacific Northwest and Western Canada.

Member universities: Simon Fraser University, University of Alberta, University of British Columbia, University of Calgary, University of Lethbridge, University of Manitoba, University of Regina, University of Saskatchewan, University of Victoria and University of Washington.

Affiliate: Portland State University.

The Pacific Institute for the Mathematical Sciences (PIMS) is a collaborative network dedicated to the promotion of discovery, understanding and awareness in the mathematical sciences. PIMS brings together leading researchers from major Universities across western Canada, as well as the University of Washington, and is a Unité Mixte Internationale of the National Center for Scientific Research (Le Centre national de la recherche scientifique, CNRS).

PIMS sponsors and organizes educational and community outreach, aboriginal math camps, and summer schools for both teachers and students, as well as initiatives to promote diversity in mathematics, partnerships that bring mathematical research to industry, cutting edge mathematical and scientific research, and events across the PIMS network that promote advancement in computer science, pure and applied mathematics, and statistics.

The central office is at the University of British Columbia, with a PIMS site office and a Site Director local to each of the nine member universities. The Site Director facilitates local opportunities and synergies, while the PIMS site offices provide administrative assistance for organizing local events. This distributed structure renders it quite unique, involving strong local site offices and activities, and allowing a broad impact across Western Canada and beyond.

The Board of Directors oversees the administration of PIMS, with membership consisting of the VP of Research from each of the member universities, as well as distinguished scientists and representatives from industry. An independent Scientific Review Panel composed of internationally renowned mathematical scientists assesses proposals for scientific events and programs.

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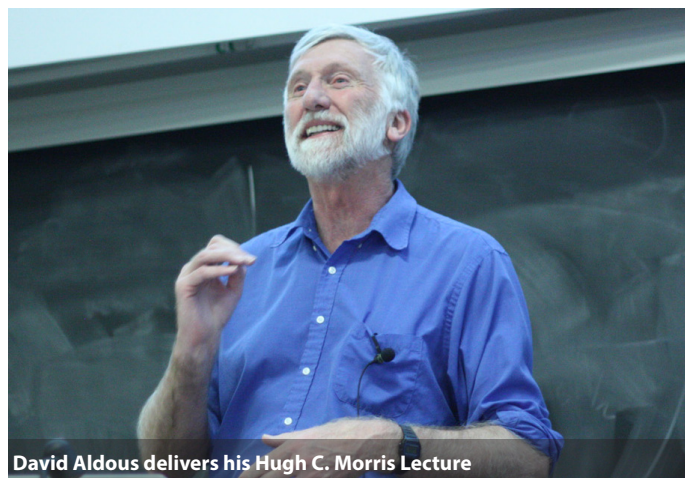Vancouver BC, V6T 1Z4
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2016 & 2017 Activity Overview

PIMS 20th Anniversary: 2016 officially marked 20 years of PIMS. Simon Fraser University, a founding member of PIMS, was the first PIMS site to celebrate our 20th anniversary with a special lecture on Data Driven Medicine by esteemed SFU alumna, Nataša Pržulj. The PIMS 20th Anniversary celebration continued through 2017, with events hosted at every PIMS site.

In 2016 & 2017, PIMS supported more than 180 scientific activities. These involved more than 10000 participants who spent over 21000 days at PIMS activities.

Conferences and Workshops: Events in 2016 and 2017 delved into a broad range of mathematical areas. Some of these included the *MMMM Graduate Combinatorics Workshop* and *Prairie Discrete Math Workshop* at UManitoba, *the International Biometrics Conference* at UVictoria, the *International Congress of Theoretical and Applied Mechanics* in Montreal, the *Conference on Quantum Information Processing* in Banff, Alberta, and the *Current Trends in Dynamical Systems & The Mathematical Legacy of Rufus Bowen Conference* at UBC, our largest event to date.

Summer Schools: The calendar included the *PIMS Summer School and Workshop on Geometric and Topological Aspects of the Representation Theory of Finite Groups* and *Two Weeks in Vancouver - A Summer School for Women in Math* at UBC, the *PIMS Summer School in Mathematical Finance* at UofA, the *2017 Summer School in Probability* featuring a mini-course taught by fields medalist Martin Hairer, the *2016 West Coast Algebraic Topology Summer School* at the University of Oregon, and the *14th Meeting of the Canadian Number Theory Association (CNTA XIV)* at the UofC.

Lecture and Seminar Series: PIMS supports 28 seminar series each year. In 2016 and 2017, these included several distinguished colloquia series across the sites, featuring the new *Abelian Varieties Multi-Site Seminar Series* (organized by the CRG in that area) a monthly seminar on the theme of explicit methods in abelian varieties. These talks were held across all PIMS institutions including ULethbridge, USaskatchewan and UManitoba. and were broadcast via conference, recorded and posted on *mathtube.org*.

Distinguished and Public Lectures: One of our goals is to bring some of the best mathematicians in the world to PIMS sites and these past two years have honoured us with some amazing speakers. Highlights: Cédric Villani (Institut Henri Poincaré), Peter Lu (Harvard University), Silvia Serfaty (Courant Institute, NYU), Ken Ono (Emory University), Maria Chudnovsky (Princeton University), Jacob Lurie (Harvard University), Edriss Titi (University of California, Irvine), and Bruce Sheperd (McGill University).

David Aldous delivers his Hugh C. Morris Lecture

Lunchbox Lecture: Krisztina Vasarhelyi on Systems Modeling for HIV Health Service Delivery

2016 Women in Math Panel

Collaborative Research Groups

PIMS Collaborative Research Groups (CRGs) develop research and training networks, establishing lasting interdisciplinary links between geographically dispersed groups of researchers at member universities. CRGs organize thematic activities, such as workshops, summer schools and seminars, make joint postdoctoral fellowship (PDF) appointments, and/or develop joint graduate training programs. PIMS has developed 30 CRGs since its inception in areas ranging across all the mathematical sciences. These have served as catalysts for producing mathematical research of the highest quality in Western Canada and attracting outstanding faculty to PIMS universities.

PIMS had six CRGs operating in 2016-2017: Applied Combinatorics (2014-2017); Applied, Algebraic and Geometric Topology (2014-2018); Explicit Methods for Abelian Varieties (2015-2018); Applied Partial Differential Equations: Modeling, Analysis, and Computation (2015-2018); Geometric and Cohomological Methods in Algebra (2016-2019); Geometric Analysis (2016-2019).

Geometric and Cohomological Methods in Algebra (2016-2019)

Universities in Western Canada have been traditionally strong in algebra, in particular in representation theory and the theory of Lie algebras. More recently, the algebra community in Western Canada was solidified and strengthened by the highly successful PIMS CRG in 2005-08, which helped junior researchers and recent arrivals integrate into preexisting networks. The algebraists in Western Canada are at the forefront of developments in algebra, which have been influenced by an infusion of new techniques from algebraic geometry and algebraic topology.

The community of algebraists at PIMS universities has been strengthened since 2008 and collectively, we now have a strong regional group of researchers in algebra. The five CRG organizers work in overlapping research areas of central interest in algebra: Lie algebras, quadratic forms, central simple algebras, modular representation theory, algebraic groups, homogeneous spaces, Galois cohomology, and motives.

Our impact and productivity will be amplified through scientific exchanges, joint seminars and workshops, sharing postdocs and distinguished visitors, and creating new research and training opportunities for our students.
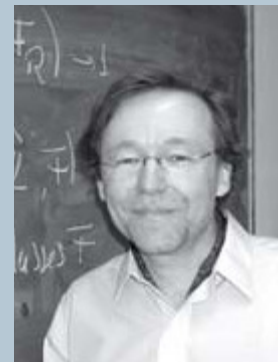
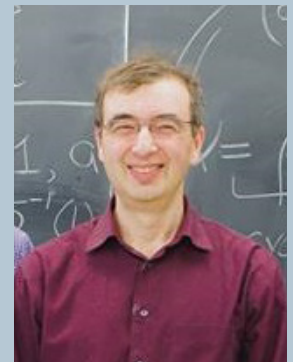## CRG Leaders

Vladimir Chernousov (UAlberta)

Nikita Karpenko (UAlberta)

Julia Pevtsova (UWashington)

Arturo Pianzola (UAlberta)
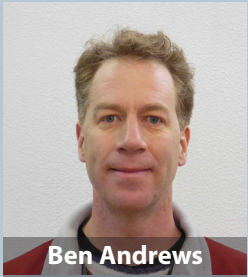
Zinovy Reichstein (UBC)

Geometric Analysis (2016-2019)

This three-year long CRG aims to enhance connections and stimulate collaborations among the mathematicians at the four institutions (the Australian National University, the Beijing International Center for Mathematical Research, the University of British Columbia and the University of Washington) and beyond. Involvement of young researchers and training of graduate students constitutes a major component of the CRG. The idea of sending people, especially postdocs and students, to different places for a relatively long stay (one to three months) is new and exciting, and can be very productive. Summer schools and conferences will be organized in Beijing, Canberra, Seattle and Vancouver. Research connections will focus on, but will not be limited to, the following main themes:

(1) Geometric variational problems - minimal surfaces, harmonic maps and their applications

(2) Geometric evolution equations - mean curvature flow, Ricci flow and other curvature flows

(3) Complex differential geometry

(4) Mathematical general relativity

(5) Nonlinear PDEs - the Monge-Ampere equation, the special Lagrangian equation

CRG Leaders

Australian National University

Ben Andrews

Xujia Wang

Neil Trudinger

University of British Columbia

Albert Chau

Jingyi Chen

Ailana Fraser
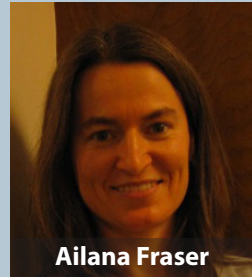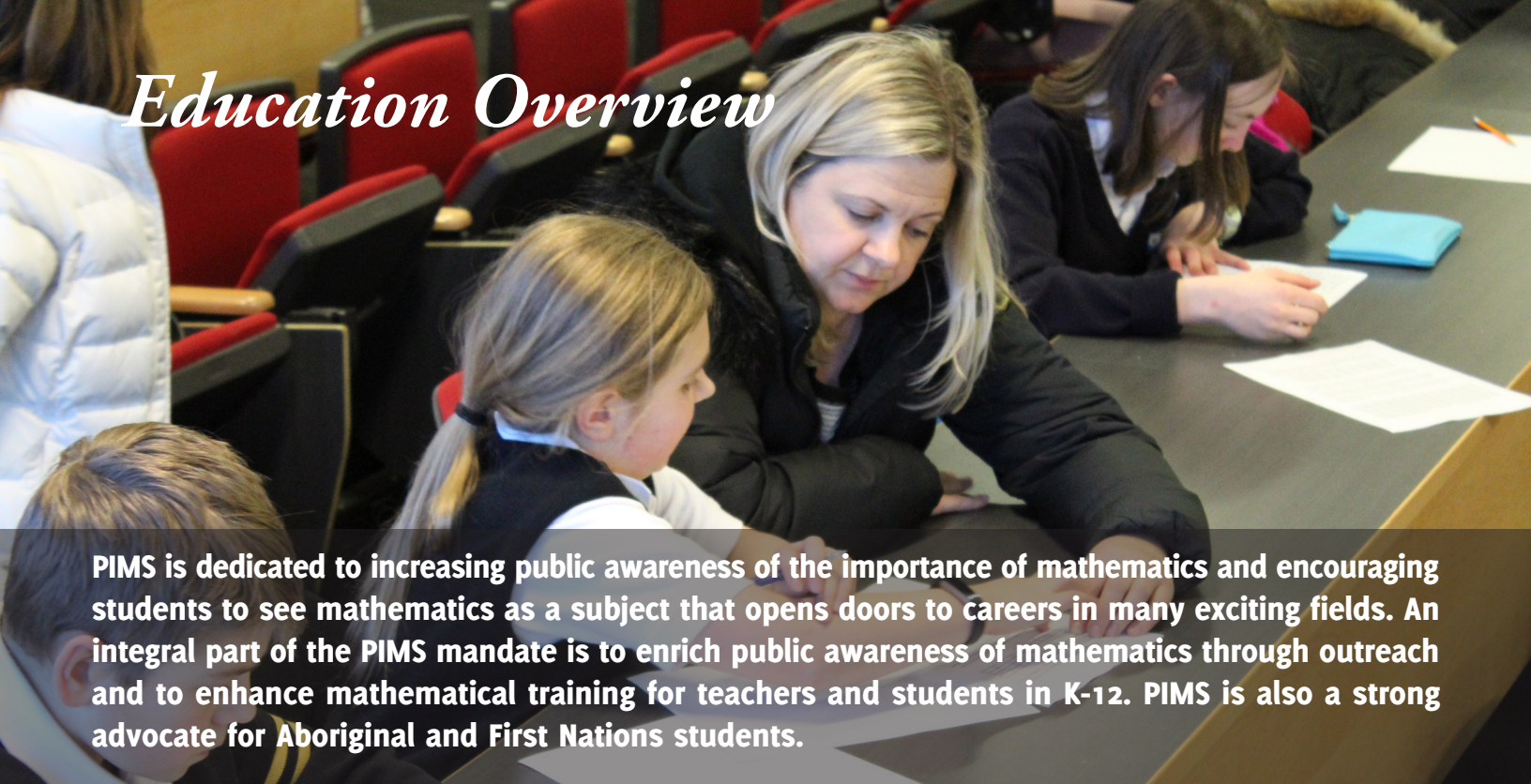
Beijing International Centre for Mathematical Research

Gang Tian

Yuguang Shi

Xiaohua Zhu

University of Washington

John Lee

Dan Pollack

Robin Graham

Yu Yuan
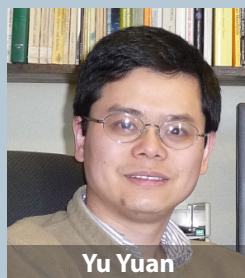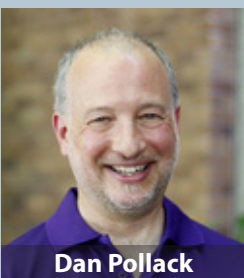
Education Overview

PIMS is dedicated to increasing public awareness of the importance of mathematics and encouraging students to see mathematics as a subject that opens doors to careers in many exciting fields. An integral part of the PIMS mandate is to enrich public awareness of mathematics through outreach and to enhance mathematical training for teachers and students in K-12. PIMS is also a strong advocate for Aboriginal and First Nations students.

2016 & 2017 were busy for PIMS Education outreach programs. Here are just some of our major 2016 Projects:

Math Summer School for Elementary School Teachers

PIMS, in partnership with the Departments of Mathematics at UBC and SFU, created the Math Summer School for Elementary School Teachers in 2015 so that we can work with elementary school teachers to develop the necessary math knowledge and experience that will make them comfortable teaching mathematics.

21 in-service teachers attended the summer school in 2016 from July 4-29. It is one of the best programs we offer as it is a direct conduit to improving mathematical education. From one attendee: "I learned to really enjoy math. I learned the importance of appreciating different learning styles and this is something I will want to include in my classes moving forward. I'm more motivated than ever to provide exciting lessons for my students."

SFU Academic Camp for Aboriginal Students

The 2016 summer camp for Aboriginal Students ran from July 4-29. This program is organized and supported by PIMS, the SFU Faculty of Science, the SFU Office for Aboriginal Peoples, the IRMACS Centre, and the SFU Department of Mathematics.

Our goal is to increase Aboriginal student participation, retention and high school graduation rates by providing a more solid foundation in Mathematics, Science and English in preparation for admission and success in post-secondary institutions. This camp gives Aboriginal students exposure to real-life work experience with faculty and members of the University community. Working in a field of their choice, the program empowers students and helps them realize that University is a place for them to succeed.

The Aboriginal Math Symposium

Through our partnership with UBC Education. This symposium is an opportunity for teachers, administrators, Ministry representatives, community members, and academics to connect, explore and share new ideas, resources and research on Aboriginal mathematics education from kindergarten to Grade 12.

Together we work to learn about new research in mathematics and Aboriginal education and develop community connections to facilitate and support improving current systems.

Math Mania

2017 saw the expansion of our Math Mania program. Thanks to the dedicated work of PIMS Manitoba Education Coordinator Darja Barr, Math Mania made it to First Nations communities in Manitoba. At the end of May and into the first two weeks of June, 2017, Darja visited three communities in what were the first mathematics events of their kind in Manitoba: Opaskwayak Cree nation, The Pas; Sagkeeng First Nation Reserve, Pine Falls; Lake St. Martin School, Winnipeg.

Each site hosted a PIMS Math Mania event which ran for 30 minute blocks in the mornings, encouraging groups of students from grades K-8 to take part in a variety of educational math games. From Popsicle Stick Puzzles to the Error Correcting Code Game to a giant human-sized sorting algorithm that the kids could literally walk through, there was something for every student to find their own joy in mathematics.

Under the direction of PIMS UBC Education Coordinator Dr. Melania Alvarez, the program also expanded into the Yukon with the help of two volunteers from the region.

45,000 and Counting: The PIMS Education Legacy

As part of our 20 year round-up through 2016 and 2017, assessing the deliverable and head-count metrics of our combined education programming, we did the math to see just how much we've accomplished so far. After tallyiing the numbers, we found that PIMS Education has reached and influenced over 45,000 students and 5,400 teachers across western Canada over the course of its 20 year deployment. This number increases when you consider our many publications, partnerships and education conferences like Changing the Culture which spread the message beyond the scope of what we can measure. You can read the full education story online on our medium channel (@pimsmath).

Postdoctoral Fellows

Every year PIMS sponsors numerous postdoctoral fellows (PDFs), attracting outstanding young scientists who contribute to PIMS research programs, many of whom later become faculty members at Canadian universities. PDFs are distributed throughout PIMS sites on a competitive basis. In addition, each CRG is allocated a number of PDFs, the selection of which is determined by an assessment panel. In 2014 PIMS supported a total of 42 PDFs distributed among all its sites.

2016-2017 postdocs:

Benjamin T Wallis (UAlberta)
Taiki Shibata (UAlberta)
Ariana Bianchi (UAlberta)
Niushan Gao (ULethbridge)
Ferdinand Ihringer (URegina)
Varvara Shepelska (USaskatchewan)
Claire Boyer (SFU)

Mattia Talpo (SFU)
Ling Xue (UManitoba)
Jennifer Jaye Vaughan (UManitoba)
Tobias Huxol (UBC)
Nguyen Lam (UBC)
Ben Krause (UBC)

Featured Postdoctoral Fellow: Ben Krause

"When I entered grad school at UCLA in 2010, I was initially interested in number theory -- so much so that I viewed my first quarter of graduate real analysis as essentially a "cultural" experience. In early conversations with some of the older analysis students, I learned about the following seemingly number-theoretic "fairness" property: almost every number has a proportional number of zeros, ones, twos, etc. in its decimal expansion. The idea that analytic methods -- this result is proven using ergodic theory -- could reveal such a beautiful number theoretic phenomenon drew me to analysis, and ergodic theory in particular. I completed my dissertation in pointwise ergodic theory 2015, under the advisement of Terry Tao -- who taught my first analysis course.

As was the case in graduate school, much of my current research deals with quantitative aspects of ergodic theory; the flavor of question that interests me concerns the rate at which the error terms tends to zero. These questions live at the interface of ergodic theory, number theory, and harmonic analysis. Right now, the field of pointwise ergodic theory is going through exciting changes, as techniques from singular integral theory and time frequency analysis have become increasingly important; some of the problems that I am thinking about seem to require Gowers-style higher order Fourier analysis, which I am eager to learn in the coming months. UBC and PIMS have been very supportive in encouraging me to organize a conference on pointwise ergodic theory and related fields in the spring of 2018, and I am very excited to see the impression that mathematicians from UBC and the rest of Canada leave on the field!"

2016 marked the PIMS second Postdoctoral Training Centre in Stochastics.

These groups, under the leadership of Ed Perkins, have joined forces through the new PIMS PTCS to train an outstanding cadre of postdoctoral fellows. In its first year, the program attracted $550,000 in NSF funds for our University of Washington site, in addition to the support from the Province of Alberta. The PTCS organizes summer schools in probability and mathematical finance, develops networking between PIMS sites and with groups in Microsoft Research and Eastern Canada. It also supports distinguished visitors.

The Second Annual PTCS Retreat was held Sept. 23-25, 2016 at the Banff International Research Station (BIRS). This year saw all seven postdoctoral fellows supported by the PTCS giving 40 minute presentations to a total of 26 participants. Included were postdoctoral fellows from USaskatchewan and Microsoft Research, PhD students from UWashington and UCalgary, and senior faculty from UCalgary, UAlberta, Simon Fraser University, UWashington and UBC.

Presentation Highlights:

Mathav Murugan (PTCS, UBC) presented a stable characterization of the Elliptical Harnack Inequality was the first announcement of this fundamental work with Martin Barlow. This presentation outlined results that have eluded experts since Barlow and Bass proved the analogous result for the Parabolic Harnack Inequality in 2006.

Simone Brugiapaglia (PTCS, SFU) spoke on his work in a newly emerging field--the use of compressed sensing methods to numerically solve partial differential equations. He showed how randomized sparse recovery methods can significantly lower computational costs.

Noah Forman (PTCS, UW) presented his work on partition-valued diffusions and their relationship with population genetics. The dynamics underlying Forman's construction offer an important forward step which would have Aldous' CRT as its stationary distribution; this has been an open problem since the 90's.

2016 Results: Discussions and shared research surrounding the various presentations at this year's PTCS Retreat resulted in debate, burgeoning collaborations, a holistic overview of applied probability and excitement for next year's event.

Again, we give special thanks to BIRS for supplying the spectacular backdrop of Banff for a highly successful meeting.

2016 attending postdocs:

Simone Brugiapaglia (Politecnico di Milano)
Noah Forman (U. Cambridge)
Jonathan Allan Chávez Casillas (UCalgary)
Mathav Murugan (UBC)

Richard Balka (UBC)
Khoa Le (Ucalgary/UAlberta)
Zhenan Wang (UWashington)

2016 Prizes & Awards

CRM - Fields - PIMS Prize
Daniel Wise (McGill University)

Wise's fundamental research contributions lie at the core of what is widely considered as the most important development in geometry and topology since Perelman's celebrated proof of the Poincaré Conjecture, namely the proof of Thurston's virtually fibered conjecture for hyperbolic three-manifolds. It has also been central to the resolution of major open problems such as Waldhausen's virtual Haken conjecture and Baumslag's famous 1968 conjecture which states that every one-relator group with torsion is residually finite.

Professor Wise is widely recognized as one of the top geometric group theorists in the world, winning multiple awards in his field. He delivered an invited address at the 2014 International Congress of Mathematicians in Seoul and, in that same year, he was elected a Fellow of the Royal Society of Canada in 2014.


CAIMS/PIMS Early Career Award in Applied Mathematics
Jean-Phillippe Lessard (Laval University)

Professor Lessard's research interests are in dynamical systems. In particular, he uses and develops rigorous computational methods, topological methods and analytic estimates for the study of solutions of partial differential equations, delay differential equations and ordinary differential equations. Professor Lessard has made substantial contributions to the theory of rigorous computing, and was cited for being "one of the world leading experts in the area" and "at the forefront of applied mathematics in Canada, blending traditional analysis with traditional computation to build something entirely new."

Professor Lessard will receive his award and deliver a plenary lecture at the 2016 Annual CAIMS*SCMAI meeting at the University of Alberta in June, 2016.
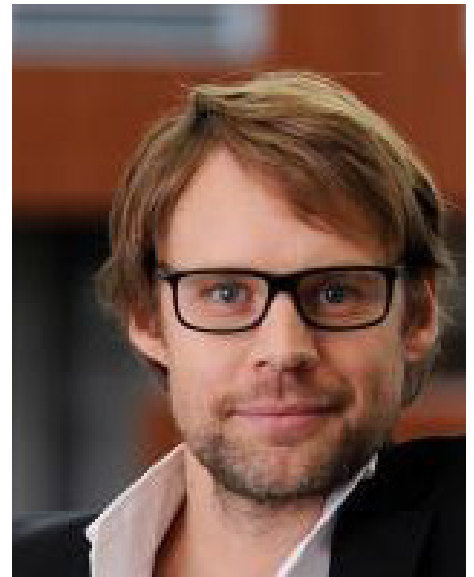
PIMS Education Prize
Patrick Maidorn (University of Regina)

Maidorn is an instructor in the Department of Mathematics and Statistics at the University of Regina. He has mathematics degrees from the universities of Guelph and Waterloo, and has worked at the University of Regina since 1997. Patrick is very active in mathematics education and outreach. As well as his role in organising math camps and school visits, he has brought the international Mathematical Kangaroo contest to Regina and played a key role in its organization. He is also a lead exam writer for the Saskatchewan Math Challenge.

"Patrick Maidorn has been exceptionally active in promoting understanding and interest in mathematics, at all levels from high school to university," remarked Martin Barlow, PIMS Interim Director.

2017 Prizes & Awards

CRM - Fields - PIMS Prize

Henri Darmon
(McGill University)

Professor Darmon is one of the leading number theorists of his generation. He has an extraordinary record of deep and highly influential contributions to the arithmetic theory of elliptic curves, including his recent breakthrough on the Birch and Swinnerton-Dyer Conjecture. He has also been an exceptional mentor to students and an exemplary citizen of the mathematical community.

Prof. Darmon obtained his Ph.D. in Mathematics from Harvard University in 1991. He has been the James McGill Professor of Mathematics since 2005

PIMS Education Prize

Anne Stokke
(University of Winnipeg)

As both a professor and a researcher, Professor Stokke is an active and passionate advocate of numeracy, math education and outreach. She is a co-founder of WISE, an organization dedicated to improving education in mathematics through strengthening both the curriculum and teacher training. Professor Stokke's promotion and advocacy for improvements in math education have inspired meaningful discussion and change.

Dr. Stokke is a professor of mathematics in the University of Winnipeg and holds degrees from Brandon University, the University of Manitoba and the University of Alberta.

Co-Winners of the CAIMS/PIMS Early Career Award in Applied Mathematics

Ben Adcock
**(Simon Fraser University)**

Professor Adcock received his PhD in 2010 from the Department of Applied Mathematics & Theoretical Physics at Cambridge. He received a post-doctoral fellowship at Simon Fraser, and held a faculty position at Purdue University. In 2014, Professor Adcock returned to Simon Fraser in his current position as Assistant Professor in the Department of Mathematics.

He has been described as a researcher who attacks classical problems "with a distinctly modern flair" and with "exceptional technical skill and creativity." It is no wonder, then, that Adcock's work promises to encourage advances in medical imaging, microscopy, and data mining.

Hau-Tieng Wu
(University of Toronto)

Professor Wu received his PhD from Princeton in 2011. He held post-doctoral positions at UC Berkeley, and Stanford before joining the Math Department at the University of Toronto in 2014 as an Assistant Professor.
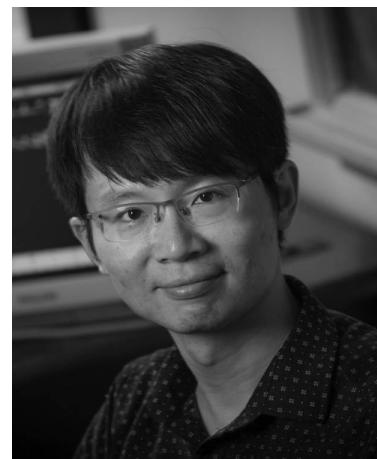
Prior to his PhD studies, Professor Wu trained as a medical doctor, and served as radiologist resident in Taiwan. Wu clearly draws on his unique experience when tackling research challenges. Indeed, his work brings results from geometry, harmonic analysis, graph theory, and statistics to bear on issues of medical and biomedical significance.

Martin Hairer at PIMS Summer School in Probability

The Summer of Three Fields Medalists

Cédric Villani (Institut Henri Poincaré): PIMS celebrated its 20th anniversary with events at each site, starting in 2016 and culminating in an event at UBC in Spring 2017. That spring event, in partnership with the Peter Wall Institute for Advanced Studies, included three talks from Fields Medalist Cédric Villani, kicking off the summer of three Fields Medalists in three consecutive months (a first for PIMS!).

Villani's talk at the Vogue Theatre in downtown Vancouver was a soldout affair and was followed by two Distinguished Lectures at the PIMS Central Office at UBC.

Martin Hairer (Imperial College London): The following month, we held our *2017 Summer School in Probability* which was attended by more than 120 participants from institutes representing 24 countries and every continent save Antarctica.

It was our second-largest event ever by attendance and featured, among mathematicians like Marek Biskup, Hugo Duminil-Copin, Sandra Cerrai, and Christina Goldschmidt, a mini course taught by Fields Medalist Martin Hairer. He was kind enough to sit down with us and discuss his career, the life of a Fields Medalist, and where he's going next in his research (see our medium channel for the full interview: @pimsmath).

Stephen Smale (City University of Hong Kong): Immediately following the Probability Summer School, we hosted the Current Trends in Dynamical Systems and the Mathematical Legacy of Rufus Bowen Conference which featured a celebration of the life of Rufus Bowen as well as a kick-off lecture from our third visiting Fields Medalist, Stephen Smale.

Smale, famous for his indelible fingerprints on the world of mathematics, having helped guide young mathematicians for over six decades, was a guest of honour at a conference in which four generations of mathematicians gathered to discuss the field of dynamics and celebrate one of Smale's most memorable students, Rufus Bowen (full story on next page).

Cédric Villani

Christina Goldschmidt

Stephen Smale

Current Trends in Dynamical Systems &
The Mathematical Legacy of Rufus Bowen

Four Generations of Mathematics

Rufus Bowen (1947-1978), Professor of Mathematics at UC Berkeley, was a rising star in dynamical systems before is sudden passing at the age of 31. Over a career of only ten years, he made profound, deep, and lasting contributions to areas of the subject that remain active today.

This conference, attended by almost 200 mathematicians young and old from all over the world, articulated and celebrated Bowen's mathematical legacy. Lectures were given by nineteen of the world's leading experts in dynamics, including Fields Medalist Stephen Smale, several ICM speakers and Fellows of various societies. Most lectures connected directly to Bowen's work and demonstrated the lsting vitality of his results. There was also a great deal of positive energy and sharing of mathematical ideas over two poster sessions with presentations by thirty-two young dynamicists, and three parallel problem sessions, each focusing on a sub-area of dynamics.

A unique feature of the conference was a focus on Bowen's private notebook in which he had catalogued 157 open problems. The Notebook was briefly referenced in a footnote to Bowen's last paper which was posthumously published in 1979, but the Notebook itself was never published or widely distributed. In November, 2016, with the help of PIMS' IT staff, the Notebook was published online as an interactive website where users can comment on progress, discuss new problems and offer new directions to tackle any of the still-open problems noted by Rufus Bowen: https://bowen.pims.math.ca. In addition to one conference plenary session on the Notebook, a large number of problems from the Notebook were discussed in the context of the problem sessions.

Finally, the conference included a lunch which celebrated Rufus Bowen as a naturally kind person with a warm sense of humour and an inspiring figure to so many young mathematicians of the 1970s. In the words of those lucky enough to have known him: "He made us better people."

The conference was the largest ever in the history of PIMS with at least 19 countries represented by the 200 attending participants. Rufus Bowen left an indelible legacy in the world of mathematics, and it was

Innovation Platform

Canadians Land on Jupyter

PIMS, in partnership with Compute Canada and Cybera, launched a cloud-hosted scientific computing and data science platform for Canada. The service, *syzygy.ca*, delivers Jupyter to faculty, staff and students at Canada's universities using single-sign-on (SSO) via their university user account. By eliminating the requirement to install customized software on personal computers, syzygy.ca makes it easier for research teams to collaborate using the right tools for their investigations. The platform delivers an interactive coding environment for literate programming in Python 2, Python 3, R (and sometimes Julia, Octav, Sage and other languages).

PIMS is leveraging syzygy.ca and other tools to develop expertise in scientific computing, data science, machine intelligence, optimization, etc. Jupyter service is available today at several universities (UBC, SFU, UofT, Waterloo, Queen's, Victoria, Saskatchewan, Calgary, Lethbridge). Colleges, universities, and other prospective partners can request Jupyter service via syzygy.ca. What the PIMS team has accomplished with the Syzygy platform is the largest Jupyter hub in the world connected from Ontario to Washington; and each mont, we're deploying the service at more and more institutions.

The platform has been used for seminars on Python and Git, machine learning with SciKit Learn, neural networks and deep learning, undergraduate courses on mathematical computing, computer science, and statistics, and graduate courses on mathematical modeling for industry, seismic inverse problems, and computational finance. Academy-industry partnerships are forming to investigate data science challenges arising in business through a workshop built atop syzygy.ca.

The syzygy.ca platform democratizes access to digital research infrastructure. PIMS and our partners advance Canada's research capacity by connecting human talent to curated tools from the mathematical sciences, diverse data sources, excellent documentation and training programs.
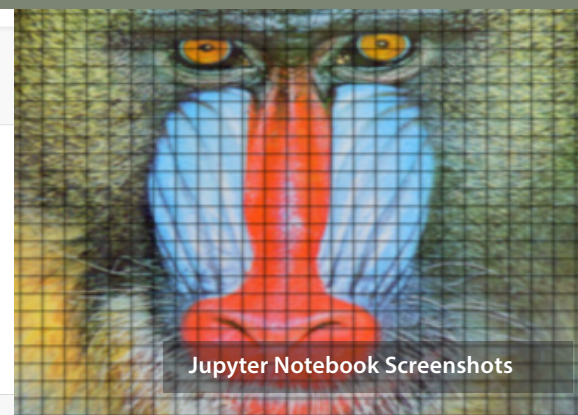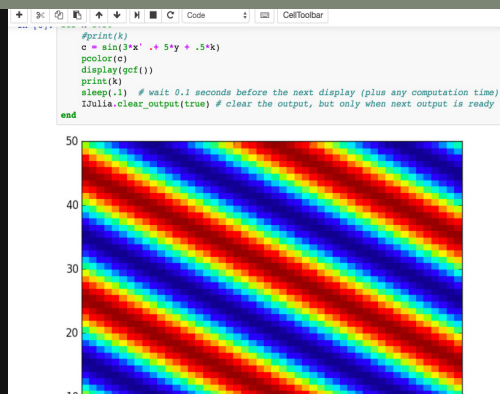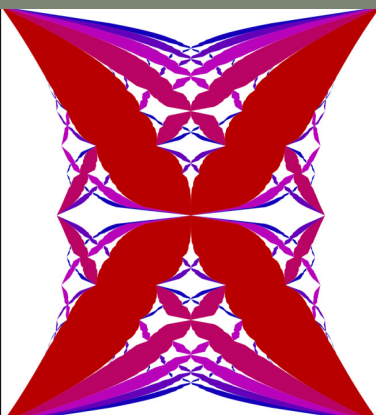
Jupyter Notebook Screenshots

Lunchbox Lecture Highlights & Math Modelling

PIMS Lunchbox Lecture with Robert Deardon | March 3, 2016 | University of Calgary

This lecture was convened to discuss Bayesian study design for nonlinear systems with a specific look at an animal disease transmission case study. Deardon illustrated the use of a Bayesian framework by considering the design of an animal disease transmission experiment where the underlying goal is to identify some characteristics of the disease dynamics (e.g. a vaccine effect, or the infectious period).

PIMS Lunchbox Lecture with Dave Fracchia | March 10, 2017 | Simon Fraser University

Discussing the mathematics of Game Design, Dave Fracchia of the Centre for Digital Media lectured on the ubiquity of mathematical science in the development of player input, NPC behaviour, physics simulations, real-time rendering and level creation. The lecture gave an overview of how even the most basic knowledge of the fields of logic, probability, and statistics benefit a game designer.

Graduate Math Modelling in Industry Workshop | August 7-13, 2016 | University of British Columbia

The Mathematical Modelling in Industry Workshop for Graduate Students is designed to provide graduate students and qualified advanced undergraduates with first-hand experience in industrial research in the mathematical sciences.

This 2016 workshop was a joint project of Le Centre de recherches mathématiques (CRM), the Fields Institute, and the PIMS, and funded through NSERC's support of the Institutes Innovation Platform. It included short courses on mathematical modelling and the use of scientific software for calculation and simulation with a focus on application to specific problems that arise in industrial settings. Teams worked on five problems: Hydro-electric reservoir management, Statistical prediction for an industrial reactor, Setting Room Capacities for Safety, Performance in re-charging lithium ion batteries, and optimisation of traffic light systems. The final wrap-up on Saturday included presentations from each team on their respective outcomes.

Targeted at graduate students in the Institute of Applied Mathematics at UBC, and students at SFU with similar interests, the 2017 bcdata Data Science Workshop had two main goals: to bring together top researchers, industry professionals and BC Math students to tackle interesting research and industry problems; and to develop data science literacy in students with strong mathematical skills who may have little or no previous experience in the realm of "data science".

The workshop hosted 50 graduate students in mathematics as well as interested industry members for a two week foray into foundational and crucial elements of the rapidly expanding field of data science. The goal was to showcase data science tools such as working with large data sets, statistical inference, and machine learning. Tools that aid in research and broaden career options after graduation.

The first week of the workshop kicked-off with a catered breakfast at UBC Robson Square, and covered introductory data science material through morning lectures and afternoon hands-on mini-projects.

On the Wednesday, August 16, students attended a career panel where they were industry professionals and mathematicians spoke on the possibilities after graduation as well as the paths they took to get to where they are today.

The second week covered advanced topics in data science through morning lectures hosted by a diverse range of professors. Coupled with this data science deep dive, students were broken into teams of 10 to tackle week-long projects as guided by an industry mentor.

All lecture notes, code and workshope materials were made available to students via a GitHub repository as students progressed throughout the weeks.

Our industry partners at Mobify hosted the career panel and, in November, eagerly provided a venue for the kick-off of our new bcdata Colloquium Series with a talk from Eldad Haber. This series will carry forward into 2018 with talks at multiple sites.

WORKSHOP PROJECTS

Industry Partner: MOJIO

Data Insights from Vehicle Time Series Messages

Industry Partner: ALTIUS INSTITUTE FOR BIOMEDICAL SCIENCES

Elucidating enhancer-promoter gene expression using ConvNets

Industry Partner: BC SAFETY AUTHORITY

A risk-based platform for accident prevention

Industry Partner: SMART SHORES

High-Resolution Shoreline Data for Flood Protection and Environmental Conservation

Industry Partner: MIDVALE APPLIED MATHEMATICS

Data-driven modeling of video compression

2018 Event Highlights

EVENTS, CONFERENCES AND WORKSHOPS

5-9 February	Geometric & Nonlinear PDE Conference New South Wales, Australia
3-4 March	Pacific Northwest Geometry Seminar (PNGS) PIMS, University of British Columbia
14-16 March	1st Canadian Geometry & Topology Conference Fields Institute
23-25 March	Workshop on Approximate Enumeration of Polygons University of British Columbia
April	Dynamics Day University of Washington
May	Alberta Number Theory Days X Banff International Research Station
May	PIMS Workshop on Geophysical Imaging and Inversion University of Calgary
6-11 May	IAM/PIMS Data Science Problem Solving Workshop Vancouver Convention Centre
22-25 May	Graph Complexes, Configuration Spaces and Manifold Calculus University of British Columbia
26-27 May	Western Canada Linear Algebra Meeting 2018 Washington State University
1-5 June	Canadian Mathematics Education Study Group Quest University
4-8 June	Canadian Operator Symposium 2018 University of Manitoba
12-15 June	2018 Prairie Discrete Mathematics Workshop Brandon University
25-29 June	Joint Canada-Asia Pacific Conference on General Relativity and Relativistic Astrophysics Theoretical Physics Institute, University of Alberta
11-15 July	Canadian Undergraduate Mathematics Conference University of Saskatchewan
16-20 July	Challenges in Probability and Mathematical Physics CRM-Montreal
16-20 July	ANTS XIII: Algorithmic Number Theory Symposium University of Wisconsin, Madison (USA)
18-20 July	Canadian Undergraduate Computer Science Conference University of Calgary
23-27 July	6th G. J. Butler Memorial Conference on Differential Equations and Population Biology University of Alberta
23-27 July	25th International Domain Decomposition Meeting St. Johns
23-29 July	International Congress on Mathematical Physics Montreal
26-28 July	The 20th IMS New Researchers Conference Simon Fraser University, Big Data Hub
6-7 August	Graph Searching in Canada 2018 (GRASCan '18) Regina
8-10 August	Canadian Conference on Computational Geometry University of Manitoba
19-24 August	Industrial Problem Solving Workshop 2018 University of Calgary

SUMMER SCHOOLS

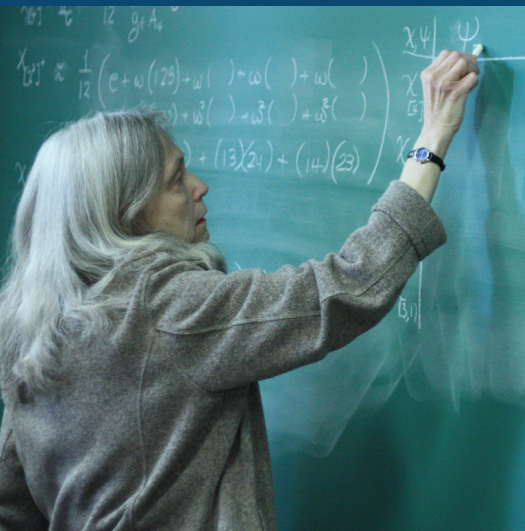|	
4-15 June	Séminaire de Mathématiques Supérieures: Derived Geometry and Higher Categorical Structures in Geometry and Physics Fields Institute
August	Diversity in Mathematics PIMS, University of British Columbia
1-15 December	Geometric and Categorical Representation Theory University of Melbourne, MATRIX University of Calgary

COLLABORATIVE RESEARCH GROUPS

2014 - 2018	Applied Algebraic & Geometric Topology
2014 - 2018	Applied Combinatorics
2015 - 2018	Explicit Methods for Abelian Varieties
2016 - 2019	Geometric & Cohomological Methods in Algebra
2016 - 2019	Geometric Analysis
2018 - 2021	High-Dimensional Data Analysis

FOCUS GROUP

2017 - 2018	Galois Representations in Arithmetic University of British Columbia

For more information and updates, visit
www.pims.math.ca

Pacific Institute *for the* Mathematical Sciences